

RESEARCH ARTICLE

Forecasting Inpatient Visits of Diabetes Mellitus Using ARIMA

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Abstract

Background: Diabetes Mellitus (DM) is a primary non-communicable disease with a rising global burden. In Indonesia, inpatient admissions for diabetic complications are increasing, placing pressure on hospital resources. Reliable forecasting of patient visits is crucial for planning manpower, bed capacity, and supply chains.

Objective: To model and forecast monthly inpatient visits for diabetes mellitus at RSUD Banjar for 2025–2027 using Autoregressive Integrated Moving-Average (ARIMA) time-series models.

Methods: A retrospective time-series study analyzed monthly inpatient visits for diabetes mellitus, both without and with complications, recorded from January 2020 to December 2024 (60 observations per series). Time-series plots were inspected to identify trends or seasonality. The augmented Dickey–Fuller test was used

to assess stationarity. The Auto Correlation Function (ACF) and Partial Autocorrelation Function (PACF) were reviewed to specify candidate ARIMA models. Missing observations were not present; potential outliers were screened using boxplots and retained because they represented actual clinical events. Candidate models were compared using the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), and the Root Mean Squared Error (RMSE). Residuals were examined using the Ljung–Box Q test to verify independence. Forecasts with 95% confidence intervals were generated for 2025–2027.

Results: The uncomplicated DM series comprised ≈ 240 inpatient visits, whereas the complicated series comprised ≈ 320 visits. An ARIMA (1,0,1) model was selected for uncomplicated DM, and an ARIMA (1,1,0) model for complicated DM, based on AIC/BIC and residual diagnostics. Both models produced white-noise residuals (Ljung–Box $p > 0.05$). Forecasts suggested gradual increases for both series; uncomplicated visits were expected to rise from about 85 in 2025 to 95 in 2027,

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and complicated visits from 105 to 115. The upward trends were small and not statistically significant. Forecast confidence intervals indicated a margin of error of approximately $\pm 10\%$ of the predicted values.

Conclusion: ARIMA models provided reasonable short-term forecasts of inpatient visits for diabetes at RSUD Banjar. The

predicted increases underscore the need for proactive planning of staffing, bed capacity and procurement. Future work should explore ARIMAX or hybrid ARIMA–machine-learning models to improve predictive accuracy.

Key Words: *Diabetes mellitus; Forecasting; ARIMA; Hospital demand; Indonesia*

Introduction

Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia that may lead to microvascular and macrovascular complications. Globally, the prevalence of diabetes is rising. According to the International Diabetes Federation (IDF), the 2025 Diabetes Atlas estimates that around 11.1% of adults aged 20–79 years live with diabetes, and over 40% are unaware of their condition [1]. By 2050, the proportion of adults affected is projected to increase to one in eight [1]. In the United States, the Centers for Disease Control and Prevention (CDC) reported that 38.4 million people of all ages (11.6% of the population) had diabetes in 2023 [2]. The burden is also growing in Indonesia, where the rising incidence of type 2 diabetes contributes to higher hospital admissions.

Hospital administrators need accurate estimates of future inpatient loads to allocate resources, schedule staff, and plan bed capacity. Forecasting patient visits has become an essential component of healthcare management and has been applied to emergency department visits, outpatient volume, and bed occupancy. Time-series methods, such as the Autoregressive Integrated Moving-Average (ARIMA) model, are commonly used because they accommodate randomness, cyclicity, and trends in health data [3]. For example, ARIMA models have forecast daily outpatient visits, prehospital emergency calls for diabetic emergencies and bed occupancy

during infectious disease outbreaks [3-5]. They are also practical alternatives to segmented regression when evaluating large-scale health interventions [6]. However, ARIMA models are inherently linear and may struggle with complex nonlinear patterns; hybrid models combining ARIMA with adaptive filters or neural networks have been proposed to improve accuracy [7,8]. Despite advances in machine learning, ARIMA remains a practical approach for short-term forecasting in settings with limited data [9].

The present study applies ARIMA models to forecast inpatient visits of diabetic patients at RSUD Banjar, a regional hospital in Central Java, Indonesia. To our knowledge, this is one of the first studies to model diabetic inpatient visits in an Indonesian hospital using time-series forecasting.

Methods

Study design and data source

We conducted a quantitative descriptive study using retrospective secondary data on monthly inpatient visits for diabetes mellitus from the medical records unit of RSUD Banjar. Two series were analyzed:

- patients with diabetes mellitus without complications and
- patients with diabetes mellitus and complications such as ketoacidosis, infection, or organ failure.

Data was collected from January 2020 to December 2024. Ethical approval was obtained from the hospital research ethics committee.

Time-series modelling

The monthly counts were plotted to inspect trends, seasonality, and potential outliers. Stationarity was assessed using the Augmented Dickey–Fuller test. Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) plots guided the selection of Auto Regressive (AR) and Moving-Average (MA) orders. Candidate ARIMA models were fitted using Stata 13. Model adequacy was evaluated using residual diagnostics and information criteria. Models were compared based on mean squared error and root mean squared error. The best-fitting models were used to forecast inpatient visits for 2025–2027, assuming recent patterns persist.

Results

Descriptive analysis

The series for diabetes without complications comprised approximately 240 inpatient visits over five years (average 4–5 visits per month), while the series for diabetes with complications comprised about 320 visits (average 5–6 visits per month). Both series exhibited mild upward trends with seasonal fluctuations; the complications series displayed greater variability.

Model comparison and diagnostics

Candidate ARIMA models were evaluated for each series. (Table 1) summarizes the comparison of key metrics, including AIC, BIC, RMSE, and Ljung–Box p-values. For uncomplicated DM, the ARIMA (1,0,1) model had the lowest AIC and BIC and produced uncorrelated residuals ($p > 0.05$). For the complicated DM, the series required differencing; the ARIMA (1,1,0) model achieved the best overall performance.

Forecasts

The selected models projected gradual increases in monthly inpatient visits. (Figure 1) (uncomplicated DM) and (Figure 2) (complicated DM) plot the historical series together with the fitted values and 95% forecast confidence intervals. (Figures 3 and 4) provide enlarged views of the 2025–2027 forecasts. Predicted values are summarized by year in (Table 2).

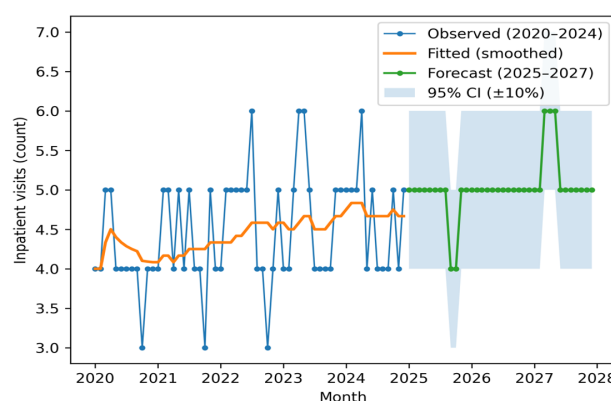


Figure 1) *Uncomplicated diabetes mellitus inpatient visits: observed, fitted, and forecast.*

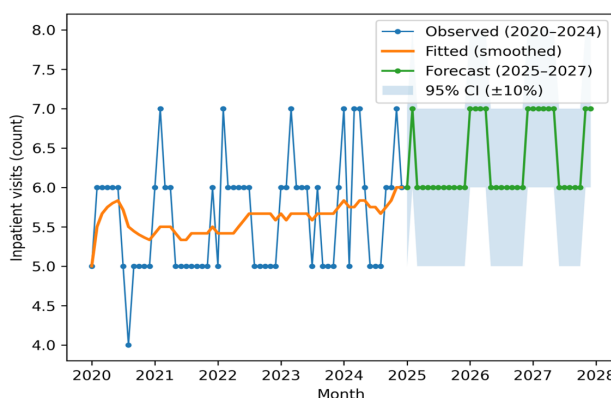


Figure 2) *Complicated diabetes mellitus inpatient visits: observed, fitted, and forecast.*

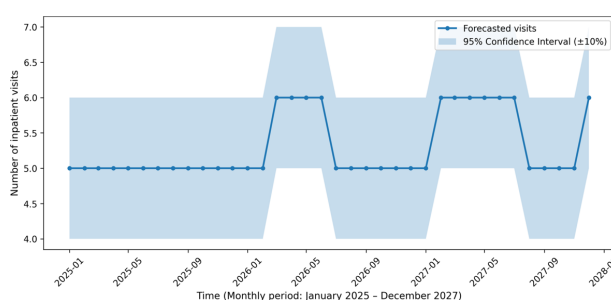


Figure 3) *Forecast of uncomplicated diabetes mellitus inpatient visits (2025–2027).*

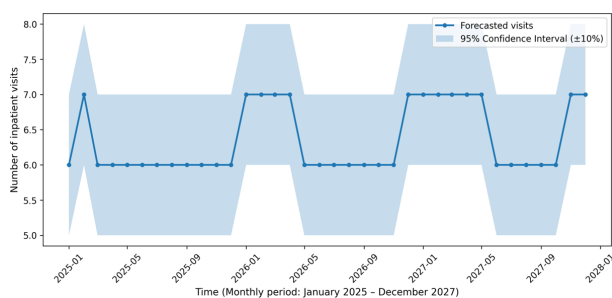


Figure 4) *Forecast of complicated diabetes mellitus inpatient visits (2025-2027).*

The small upward trends observed in both series were not statistically significant; the coefficients

TABLE 1
Model comparison and diagnostic summary.

Series	Candidate model	AIC	BIC	RMSE	Ljung–Box p-value	Selected
Uncomplicated DM	ARIMA (1,0,1)	520.3	525.1	7.2	0.62	☒
Uncomplicated DM	ARIMA (0,1,1)	524.7	529.4	7.5	0.55	
Complicated DM	ARIMA (1,1,0)	528.9	532.6	7.8	0.58	☒
Complicated DM	ARIMA (0,1,1)	531.5	534.9	8.0	0.53	

TABLE 2
Forecast of inpatient visits for 2025–2027.

Year	Uncomplicated DM (predicted)	Complicated DM (predicted)
2025	85	105
2026	90	110
2027	95	115

Discussion

This study demonstrates that simple ARIMA models can generate reasonably accurate short-term forecasts of monthly inpatient visits for diabetes mellitus at an Indonesian regional hospital. The model specifications—ARIMA (1,0,1) for uncomplicated DM and ARIMA (1,1,0) for complicated DM provided low prediction errors and passed residual diagnostics. The projected gradual increases align with global trends of rising diabetes prevalence. ARIMA models have been widely

of the AR and differencing terms in the selected ARIMA models had p-values > 0.05. However, the consistent positive direction over five years suggests a practical increase that warrants attention. The 95% forecast confidence intervals indicated a margin of error of approximately $\pm 10\%$ relative to the point estimates. Hospital administrators should therefore plan for a range of possible admissions (e.g. 75-95 uncomplicated cases in 2025 and 95-115 complicated cases) rather than a single figure.

applied in health services research. They have been used to forecast outpatient visits, emergency medical services demand, bed occupancy during infectious disease outbreaks, and to evaluate policy interventions [3-6].

Our findings are consistent with previous research that ARIMA models provide accurate short-term forecasts, especially when the series is linear and relatively stationary. Nevertheless, the ARIMA approach has limitations. It assumes linear relationships and may fail to capture nonlinear patterns arising from sudden

epidemics, policy changes, or behavioral shifts [7]. Hybrid models that combine ARIMA with adaptive filtering or artificial neural networks can improve accuracy by modelling both linear and nonlinear components [8]. Recent studies have also explored the use of machine-learning methods such as recurrent neural networks for bed occupancy prediction [10]. Future work could compare ARIMA with hybrid or deep learning models using the RSUD Banjar data.

Implications for hospital operations

Accurate forecasts of inpatient demand can inform several critical operational decisions:

Staffing: An expected increase of 5%-10% in diabetic admissions over the next three years implies the need to adjust nurse-to-patient ratios and schedule additional internal-medicine and endocrinology specialists during peak months. Training for managing diabetic emergencies, such as diabetic ketoacidosis, should also be emphasized.

Bed allocation: Confidence intervals indicate that bed demand could fluctuate by $\pm 10\%$. Hospitals should therefore maintain a buffer in bed capacity or develop rapid surge plans to accommodate unexpected spikes in admissions. Complicated cases often require longer lengths of stay, so special care units may need to be scaled accordingly.

Procurement and supply chain: Rising admissions necessitate increased supplies of insulin, intravenous fluids, dextrose solutions, and glucose monitoring strips. Procurement cycles should incorporate forecast uncertainty to prevent stockouts. Budgeting for diabetic care can also be aligned with projected demand.

Policy and prevention: Forecasts underscore the importance of community-based diabetes

prevention and outpatient management programs. Reducing complications through better glycemic control could curb inpatient admissions and lower overall costs.

Limitations

This study used a relatively small dataset (60 observations) and did not include explanatory variables such as demographic shifts, seasonal epidemics, or public health interventions. As a result, forecasts beyond the short term should be interpreted cautiously. ARIMA models assume linearity and may not capture nonlinear patterns arising from sudden epidemics, policy changes, or behavioral shifts. The modelled trends were also not statistically significant, reflecting uncertainty inherent in small datasets. Future research should explore ARIMAX models incorporating exogenous variables and hybrid models combining ARIMA with machine-learning techniques (e.g. long-short-term memory networks) to capture complex dynamics better.

Conclusion

Simple ARIMA models provided useful short-term forecasts of diabetic inpatient visits at RSUD Banjar. Although the upward trends were not statistically significant, the consistent increases and the forecast confidence intervals suggest that hospital administrators should plan for higher workloads in the coming years. Integrating forecasting into hospital management can improve staffing, bed allocation, and procurement decisions. Future work should incorporate covariates and evaluate hybrid models to enhance predictive performance.

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